DECLARATION

I, Shuichi Tomita, a professional translator, declare that to the best of my knowledge and belief the following is a true translation into the English language of the document, Japanese Patent Application No. JPAP10-292637 filed in the Japanese Patent Office on October 14, 1998.

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Method of molding plastic molding and mold for injection molding

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[TITLE OF THE INVENTION]

METHOD OF MOLDING PLASTIC MOLDING AND MOLD FOR INJECTION MOLDING

[CLAIMS]

[Claim 1]

A method of molding a plastic molding which includes preparing a pair of molds having at least one or more transfer surfaces, a slidable cavity die for forming a surface other than the at least one or more transfer surfaces, and at least one or more cavities defined by the transfer surfaces and cavity die, heating said molds below a softening temperature of a resin, injecting the melted resin heated to the softening temperature or higher into said cavity to fill said cavity with the melted resin, generating a resin pressure on said transfer surfaces to bring the resin into close contact with said transfer surfaces, cooling down the resin below the softening temperature, and opening the molds to take out a plastic molding, said method of molding a plastic molding characterized by:

injecting a gas from at least one or more vents formed in said slidable cavity, and sliding said slidable cavity die away from the resin, when said melted resin is cooled down below the softening temperature, to forcedly form a gap between the resin and cavity die.

[Claim 2]

A method of molding a plastic molding according to claim 1, characterized in that said slidable cavity die is slid to forcedly form the gap between the resin and cavity die at the time said resin pressure is reduced to 60 MPa or lower.

[Claim 3]

A method of molding a plastic molding according to claim 1,

characterized in that said gas is injected at a pressure in a range of 0.1 MPa to 0.2 Pa.

[Claim 4]

A mold for injection molding a plastic molding, having a cavity surface for defining a cavity having a predetermined volume, and at least one or more transfer surfaces on said cavity surface, said cavity being filled with a melted resin heated to a softening temperature or higher and injected thereinto to transfer the transfer surfaces to said resin with a resin pressure generated in said cavity,

said mold for injection molding a plastic molding characterized by comprising a cavity die for forming wall surfaces of the at least one or more cavity surfaces except for said transfer surfaces, and a vent formed in said cavity die, said cavity die being made slidable for forming the entirety or part of the wall surfaces of the at least one or more cavity surfaces except for said transfer surfaces, wherein a gas is injected from said vent, and said slidable cavity die is slid away from the resin when said resin pressure reaches a predetermined pressure to forcedly form a gap between the resin and slidable cavity die.

[Claim 5]

A mold for injection molding a plastic molding according to claim 4, wherein the resin pressure within said cavity is set to 60 MPa or lower when said slidable cavity die is separated from the resin.

[Claim 6]

A mold for injection molding a plastic molding according to claim 4, wherein said gas is set at a pressure in a range of 0.1 MPa to 2 MPa.

[Claim 7]

A mold for injection molding a plastic molding according to claim 4, wherein said vent is located in said slidable cavity die.

[Claim 8]

A mold for injection molding a plastic molding according to claim 4, wherein said vent is located between said slidable cavity die and an adjacent cavity die.

[Claim 9]

A mold for injection molding a plastic molding according to claim 4, comprising a pressure controller for applying a pressure to said slidable cavity die, wherein said slidable cavity die is applied with a pressure by said pressure controller such that the resin pressure within said cavity is equal to or higher than a predetermined pressure.

[Claim 10]

A mold for injection molding a plastic molding according to claim 4, 5 or 9, wherein said pressure controller comprises driving means including a hydraulic cylinder or an electric motor, such that said slidable cavity die is slid by said driving means.

[Claim 11]

A mold for injection molding a plastic molding according to claim 4, 5, 9 or 10, comprising pressure detecting means arranged in said cavity for detecting the resin pressure in said cavity, and sliding means for sliding said cavity die based on information detected by said pressure detecting means.

[Claim 12]

A mold for injection molding a plastic molding according to

claim 4, wherein said slidable cavity die has a surface in contact with the resin, said surface being treated with a material having a low adhesion with the resin.

[Claim 13]

A mold for injection molding a plastic molding according to claim 4, comprising a step formed on a surface of said transfer surface which is connected to said slidable cavity die.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Technical Field Pertinent to the Invention]

The present invention relates to a method of molding plastic moldings such as plastic moldings for applications in optical scanning systems in laser-based digital copiers, laser printers or facsimile apparatus, optical devices such as video cameras, optical discs, and the like, particularly, thick plastic lenses, plastic mirrors or the like having highly accurate mirror surfaces in thickness-varying shape, and a mold for injection molding which can facilitate the separation of a cavity die from a molding resin to reduce deformation of a product due to an adhesion of the molding resin to the cavity insert upon separation, thereby improving the molding accuracy of the plastic moldings.

[0002]

[Prior Art]

Injection molding methods for plastic products may be classified into a normal injection molding method and an injection compression molding method. The normal injection molding method involves injecting a melted resin into a cavity having a fixed volume

of a mold, the temperature of which is set below the softening temperature of the molding resin, to fill the cavity with the melted resin, cooling down the resin while controlling a follow-up pressure, and opening the mold to take out the molding. The injection compression molding method, which employs a slidable transfer die within a mold for forming a transfer surface, involves injecting a melted resin into a cavity having a predetermined volume of a mold, the temperature of which is set below the softening temperature of the molding resin, to fill the cavity with the melted resin, and sliding the transfer die following the shrinkage of the volume of the resin to apply the resin with a pressure during the cooling associated with a controlled follow-up pressure to highly accurately form the shape of the molding.

In these methods, the resin pressure and resin temperature are preferably uniform within the mold when the resin is cooled down for solidification. However, the injection molding method suffers from non-uniform resin temperatures in a thicker portion and a thinner portion during the cooling when a molding has a varying thickness, causing a residual pressure in the thinner portion or a sink in the thicker portion. In addition, for molding a thick molding, a resin largely shrinks in volume during a cooling process, making the same more prone to sinks. When a larger filling pressure is applied to prevent sinks, a large residual distortion occurs, thereby failing to provide a highly accurate molding.

[0003]

The injection compression molding method in turn can carry out the molding at a lower filling pressure than the injection molding method. However, with a thickness varying shape, the injection

compression molding method suffers from a difference in the amount of shrinkage due to a difference in thickness of a molding, which prevents the transfer die from following the shrinkage of the resin, causing separation of the transfer die from the resin, a sink produced from the point of the resin from which the transfer die is separated, and a resulting degradation in shape accuracy. To solve such problems, Laid-open Japanese Patent Application No. 6-304973 proposes an injection mold (hereinafter called the first prior art example). This injection mold comprises a vent formed on a surface other than a transfer surface (mirror surface), and generates a pressure difference between the transfer surface and the vicinity of the vent to produce a sink near the vent, thereby avoiding an internal distortion to prevent a sink on the mirror surface. Japanese Patent Application 9-164316 in turn slides a cavity die for forming a surface other than a transfer surface away from a resin to forcedly define a gap between the resin and cavity die to produce a sink in a portion of the resin facing the gap to prevent a sink on the transfer surface, and to reduce an internal distortion remaining in a molding (hereinafter called the second prior art example). However, in the first prior art example, the sink does not extend widely over the surface other than the transfer surface but concentrates near the vent. Therefore, when a larger molding is concerned, portions largely spaced from the vent are not benefitted from the effect of preventing a sink in other portions by producing the sink near the vent, resulting in a sink produced in a portion of the transfer surface largely spaced from the vent.

In the second prior art example, in turn, for providing a larger molding with a high accuracy, a more extensive sink must

be purposefully produced on a surface other than the transfer surface, so that a large contact area is inevitable between the separating cavity die and resin to increase the adhesion between the resin and cavity die upon separation, causing a deformation of the molding due to the adhesion.

[0004]

[Problem to be solved by the Invention]

Therefore, the present invention has its challenge to devise a molding method and a mold for injection molding which can highly accurately manufacture even a large molding, a thick molding, or a thickness varying molding at a low cost by reducing the adhesion between a resin and a cavity die in the foregoing prior art which forcedly defines a gap between the resin and cavity die to generate a sink in a portion of the resin facing the gap.

[0005]

[Means Taken for Solving the Problems]

[Solution 1]

Solution 1 made for solving the problems is based on a method of molding a plastic molding which includes preparing a pair of molds having at least one or more transfer surfaces, a slidable cavity die for forming a surface other than the at least one or more transfer surfaces, and at least one or more cavities defined by the transfer surfaces and cavity die, heating the molds below a softening temperature of a resin, injecting the melted resin heated to the softening temperature or higher into the cavity to fill the cavity with the melted resin, generating a resin pressure on the transfer surfaces to bring the resin into close contact with the transfer surfaces, cooling down the resin below the softening

temperature, and opening the molds to take out a plastic molding, wherein:

a gas is injected from at least one or more vents formed in the slidable cavity, and the slidable cavity die is slid away from the resin, when the melted resin is cooled down below the softening temperature, to forcedly form a gap between the resin and cavity die.

[0006]

[Implementation 1]

In implementation 1 of the solution 1, the slidable cavity die is slid to forcedly form the gap between the resin and cavity die at the time the resin pressure is reduced to 60 MPa or lower.

[Implementation 2]

In implementation 2 of the solution 1, the gas is injected at a pressure in a range of 0.1 MPa to 0.2 Pa.

[0007]

[Actions]

Solution 1 provides the following actions.

Solution 1 prepares a pair of molds (see Fig. 1) having at least one or more transfer surfaces, a slidable cavity die for forming a surface other than the at least one or more transfer surfaces, and at least one or more cavities defined by the transfer surfaces and cavity die, heats the molds below a softening temperature of a resin, injects the melted resin heated to the softening temperature or higher into the cavity to fill the cavity with the melted resin, generates a resin pressure on the transfer surfaces to bring the resin into close contact with the transfer surfaces, and cools down

the resin below the softening temperature. In this event, the slidable cavity is slid away from the resin, while a gas is injected from the at least one or more vents formed in the slidable cavity die to forcedly form a gap between the resin and slidable cavity die (see Fig. 2). After cooling down the resin below the softening temperature, the molds are opened to take out a molding. When a plastic molding is molded in this method at such a low filling pressure that can cause a sink therein, the gas injected from the vent enters between the resin and slidable cavity die, facilitating the separation of the slidable cavity die from the resin, when the slidable cavity die is separated from the resin during the cooling of the resin below the softening temperature. As the slidable cavity die is slid to form the gap between the cavity surface and resin, an adhesion (binding force) with the slidable cavity die disappears, so that a contractile force associated with the cooling of the resin is applied on the cavity surface formed by the slidable cavity die. Also, a concave or convex shape is purposefully and selectively formed on the cavity surface formed by the slidable cavity die (see Fig. 3) because an intervening air layer in the gap causes the cavity surface in contact with the air layer to delay in cooling, with a smaller thermal conductivity than the other cavity surface. As a result, a transfer accuracy can be improved for the transfer surfaces. Particularly, when this molding is an optical element such as a lens, a highly accurate molding can be provided with a small residual distortion because of the ability to set the low resin pressure which is generated by injecting the melted resin into the molds for filling.

In Solution 1, when the slidable cavity die is slid to forcedly

form the gap between the resin and cavity die at the time the resin pressure is reduced to 60 MPa or lower, the cavity surface can be purposefully and selectively formed in a concave and convex shape by the slidable cavity die.

[0008]

Also, when the gas is injected at a pressure in a range of 0.1 MPa to 0.2 Pa, the slidable cavity die can be readily separated from the resin.

Further, when transparency is required for an optical element to be molded, the resin can be a non-crystalline resin, the softening temperature of which is equal to its glass transition temperature, for example, polymethacrylate resin, polycarbonate resin, alicyclic acrylic resin, non-crystalline polyolefin copolymer (for example, manufactured under a product name Zeonex by Nippon Zeon Corporation), cyclic olefin copolymer (for example, manufactured under a product name Apel by Mitsui Sekisho Kagaku Kogyo Corporation), and the like. Alternatively, this molding method can use a crystalline resin, the softening temperature of which is equal to its glass transition temperature. Though not particularly limited, the gas should be air or a nitrogen gas because it is safe and inexpensive.

[0009]

[Solution 2]

Solution 2 made for solving the aforementioned problems is based on a mold for injection molding a plastic molding, having a cavity surface for defining a cavity having a predetermined volume, and at least one or more transfer surfaces on the cavity surface, wherein the cavity is filled with a melted resin heated to a softening temperature or higher and injected thereinto to transfer the transfer

surfaces to the resin with a resin pressure generated in the cavity.

The mold has a cavity die for forming wall surfaces of the at least one or more cavity surfaces except for the transfer surfaces, and a vent formed in the cavity die which is made slidable for forming the entirety or part of the wall surfaces of the at least one or more cavity surfaces except for the transfer surfaces, wherein a gas is injected from the vent, and the slidable cavity die is slid away from the resin when the resin pressure reaches a predetermined pressure to forcedly form a gap between the resin and slidable cavity die.

[0010]

[Implementation 1]

In Implementation 1 of Solution 2, the resin pressure within the cavity is set to 60 MPa or lower when the slidable cavity die is separated from the resin.

[Implementation 2]

In Implementation 2 of Solution 2, the gas is set at a pressure in a range of 0.1 MPa to 2 MPa.

[Implementation 3]

In Implementation 3 of Solution 2, the vent is located in the slidable cavity die.

[Implementation 4]

In Implementation 4 of Solution 2, the vent is located between the slidable cavity die and an adjacent cavity die.

[Implementation 5]

Implementation 5 of Solution 2 has a pressure controller for applying a pressure to the slidable cavity die, wherein the slidable cavity die is applied with a pressure by the pressure controller

such that the resin pressure within the cavity is equal to or higher than a predetermined pressure.

[Implementation 6]

In Implementation 6 of Solution 2, the pressure controller in Implementation 5 comprises driving means including a hydraulic cylinder or an electric motor, wherein the slidable cavity die is slid by the driving means.

[Implementation 7]

Implementation 6 of Solution 2 comprises pressure detecting means arranged in the cavity for detecting the resin pressure in the cavity, and sliding means for sliding the cavity die based on information detected by the pressure detecting means.

[Implementation 8]

In Implementation 8 of Solution 2, the slidable cavity die has a surface in contact with the resin, wherein the surface is treated with a material having a low adhesion with the resin.

[Implementation 9]

Implementation 9 of Solution 2 comprises a step formed on a surface of the transfer surface which is connected to the slidable cavity die.

[0011]

[Actions]

The solution provides the following actions.

In the mold for injection molding a plastic molding adapted to transfer the transfer surfaces onto a resin, the vent is formed in the cavity die for forming wall surfaces of the at least one or more cavity surfaces except for the transfer surfaces, the cavity die is made slidable for forming the entirety or part of the wall

surfaces of the at least one or more cavity surfaces except for the transfer surfaces, and the pressure controller is connected to the slidable cavity die (see Fig. 4). A gas is injected from the vent, and the slidable cavity die is slid away from the resin when the resin pressure reaches a predetermined pressure, thereby forcedly forming a gap between the resin and cavity die. When a plastic molding is molded using this mold at such a low filling pressure that can cause a sink therein, the gas injected from the vent enters between the resin and slidable cavity die, facilitating the separation of the slidable cavity die from the resin, when the ~~slidable~~ cavity die is separated from the resin during the cooling of the resin below the softening temperature. As the slidable cavity die is slid to form the gap on the cavity surface, an adhesion (binding force) with the slidable cavity die disappears, so that a contractile force associated with the cooling of the resin is selectively applied on the cavity surface formed by the slidable cavity die. Also, a concave or convex shape is purposefully and selectively formed on the cavity surface formed by the slidable cavity die because an intervening air layer in the gap causes the cavity surface in contact with the air layer to delay in cooling, with a smaller thermal conductivity than the other cavity surface. As a result, a transfer accuracy can be improved for the transfer surfaces.

[0012]

With the resin pressure set to 60 MPa or lower when the slidable cavity die is separated from the resin, a concave or convex shape is selectively formed on the cavity surface formed by the slidable cavity die.

The gas is most effectively set at a pressure in a range of

0.1 MPa to 2 MPa.

When the vent is located in the cavity die, the gas can be effectively introduced between the cavity die and resin, thereby facilitating the separation of the slidable cavity die from the resin.

Depending on the shape of the slidable cavity die, miniature grooves may be formed on the outer surface of the slidable cavity die to provide the vents between the slidable cavity die and another adjacent cavity die, thereby producing similar advantageous effects (see Fig. 5).

A pressure applying device can be connected to the slidable cavity die to apply a pressure to the slidable cavity die by the pressure applying device such that the resin pressure within the cavity reaches the predetermined pressure or higher, thereby highly accurately transferring the transfer surfaces onto the resin.

The pressure applying device may be implemented by a mechanism which has driving means including a hydraulic cylinder or an electric motor and a pressure controller for controlling a pressure applied by the driving means, thereby simplifying the mold structure.

Pressure detecting means may be further provided in the cavity for detecting the resin pressure within the cavity such that the pressure applied to the slidable cavity die is controlled based on information detected by the pressure detecting means to improve the stability of the highly accurate transfer surfaces provided by the injection molding.

Depending on the type of used resin, a high adhesion can be produced between the metal surface of the slidable cavity die and a non-transfer surface of a molding, causing difficulties in

releasing the resin from the slidable cavity die, and deformation of a resulting molding. Therefore, the surface of the slidable cavity die, in contact with the resin, can be surface-treated with a material having a low adhesion with a resin, for example, TiN (titaniumnitride), TiCN (titanium cyanide), W_2C (tungsten carbide), DLC (diamond-like carbon), WC/C (tungsten carbide/carbon composite), a teflon resin containing metal, or the like, thereby facilitating the release of the resin from the slidable cavity die.

In addition, since TiN (titanium nitride), TiCN (titanium cyanide), W_2C (tungsten carbide) are highly resistant to abrasion, a sliding surface of the slidable cavity die can be treated with these materials to additionally improve the durability of the sliding surface.

Moreover, the gas injected from the vent at the leading end of the airway could introduce into the transfer surfaces to adversely affect the shape accuracy of the transfer surfaces, so that the step can be formed on a portion of the transfer surface which is connected to the cavity surface formed by the slidable cavity die to prevent air from introducing into the transfer surface, thereby making it possible to avoid the adverse affections to the shape accuracy of the transfer surfaces (see Fig. 6).

[0013]

[Embodiments]

Next, embodiments will be outlined with reference to the drawings.

Fig. 1 illustrates a prototype of an injection mold to which the present invention is applied, wherein a lower half mold 1 and an upper half mold 2 have cavity dies 4, 5, respectively, for forming

transfer surfaces 3, 3, and the lower half mold 1, upper half mold 2, cavity dies 4, 5 and a slidable cavity die 6 define a cavity 7 for injection molding. The slidable cavity die 6 is provided for forming a non-transfer surface.

After the mold is heated below the softening temperature of a resin, the cavity is filled with the melted resin, injected thereinto, which has been heated to the softening temperature or higher. Then, a resin pressure is produced on the transfer surfaces 3, 3 to bring the resin into close contact with the transfer surfaces, and the resin is cooled down below the softening temperature. In this event, the slidable cavity die 6 is slid away from the resin to forcedly form a gap between the resin and cavity die 6. After the resin is cooled down below the softening temperature, the mold is opened to take out a molding. The foregoing is a conventional injection molding method using the mold illustrated in Fig. 1.

[0014]

Figs. 2, 3 illustrate an embodiment in which the present invention is applied to the mold in Fig. 1, wherein an airway 8 of a proper size is formed at the center of the slidable cavity die 6. This is a difference in structure with respect to the mold in Fig. 1. It should be noted that the airway 8 having a large diameter is inconvenient because a melted resin filled in the cavity introduces into a vent at the leading end of the airway 8, while the airway 8 having an excessively small diameter impedes smooth injection of a gas, so that an appropriate diameter therefor is in a range of 2/100 mm to 3/100 mm.

With this mold, the cavity 7 is filled with a melted resin, injected thereinto, which has been heated to the softening

temperature or higher, and a resin pressure is generated on the transfer surfaces to bring the resin into close contact with the transfer surfaces. Subsequently, when the resin is cooled down below the softening temperature, a gas is injected through at least one of more airways 8 formed in the slidable cavity die 6 toward the resin 9 within the cavity, while the slidable cavity die 6 is slid away from the resin in a direction indicated by an arrow B. In this way, a gap 10 is forcedly formed between the resin 9 and slidable cavity die 6, and the resin 9 is cooled down below the softening temperature. Subsequently, the mold is opened to take out a molding. When a plastic molding is molded in this method at such a low filling pressure that can cause a sink therein, the gas injected from the vent at the leading end of the airway 8 enters between the resin 9 and slidable cavity die 6, facilitating the separation of the slidable cavity die 6 from the resin 9, when the slidable cavity die 6 is separated from the resin during the cooling of the resin below the softening temperature. As the slidable cavity die 6 is slid to form the gap 10 on the cavity surface, an adhesion (binding force) with the slidable cavity die 6 disappears, so that a contractile force associated with the cooling of the resin is selectively applied on the cavity surface formed by the slidable cavity die 6. Also, a concave or convex shape 11 is purposefully and selectively formed on the cavity surface formed by the slidable cavity die 6 (Fig. 3 illustrates the formation) because an intervening air layer in the gap 10 causes the cavity surface in contact with the air layer to delay in cooling, with a smaller thermal conductivity than the other cavity surfaces (transfer surfaces 3). As a result, a transfer accuracy can be improved for the transfer surfaces.

The gap is formed between the resin and slidable cavity die 6 when the resin pressure is reduced to 60 MPa or lower.

[0015]

An embodiment illustrated in Fig. 4, which adds a pressure controller to the mold in Fig. 2, comprises a hydraulic cylinder 21 for applying a pressure to the slidable cavity die 6, and the pressure controller 22 for controlling the applied pressure. The pressure controller 22 adjusts a driving force of the hydraulic cylinder 21 to the slidable cavity die 6 to apply a pressure to the cavity die such that the resin pressure within the cavity is equal to or higher than a predetermined pressure.

[0016]

An embodiment illustrated in Fig. 5 comprises a plurality of grooves (the depth of which is in a range of 2/100 mm to 3/100 mm) symmetrically formed on the outer surface of a slidable cavity die 16 to form a plurality of airways 18 with the grooves. A gas is injected between the resin 9 and slidable cavity die 16 from vents at the leading ends of the airways 18 to form a gap 10. Even when the slidable cavity die has a cavity surface too small to provide the airway 8 in the embodiment of Fig. 2, a plurality of grooves are readily formed on the outer surface of the slidable cavity die, so that this embodiment is effective in such a case.

The grooves in this embodiment are similar to the vent in the embodiment in Fig. 2 in that their proper width and depth correspond to the diameter of the vent in the range of 2/100 mm to 3/100 mm.

[0017]

A gas injected from the vent at the leading end of the airway could introduce into the transfer surfaces to adversely affect the

shape accuracy of the transfer surfaces, so that an embodiment in Fig. 6 provides a step 30 on a portion of the transfer surface which is connected to the cavity surface formed by the slidable cavity die to prevent the gas from introducing into the transfer surface. The step 30 must have a width and a height equal to or larger than 0.3 mm, though depending on a pressure at which the gas is injected. When the gas is injected at a pressure in a range of 0.1 MPa to 2 MPa, proper width and height are in a range of 0.5 to 1 mm.

[Effects of the Invention]

(1) Effects of Invention by Solution 1

In a method of molding a plastic molding which includes preparing a pair of molds having at least one or more transfer surfaces, a slidable cavity die for forming a surface other than the at least one or more transfer surfaces, and at least one or more cavities defined by the transfer surfaces and cavity die, heating the molds below a softening temperature of a resin, injecting the melted resin heated to the softening temperature or higher into the cavity to fill the cavity with the melted resin, generating a resin pressure on the transfer surfaces to bring the resin into close contact with the transfer surfaces, cooling down the resin below the softening temperature, and opening the molds to take out a plastic molding, a gas is injected from at least one or more vents formed in the slidable cavity, and the slidable cavity die is slid away from the resin, when the melted resin is cooled down below the softening temperature, to forcedly form a gap between the resin and cavity die, thereby making it possible to purposefully and selectively form a molded surface formed by the cavity die with a convex or concave shape, to carry out the molding at a low pressure within

a range which a residual distortion produced in a molding will not affect the performance, and to consequently provide a molding having less distortion and highly accurate shape accuracy even if it is large, thick, or varying in thickness. Also, even with an injection molding method which is a low cost mass production method, in other words, even when the mold is heated below the softening temperature of a resin, a desired shape accuracy can be ensured, so that a cooling time (molding time) can be reduced to save the manufacturing cost.

(2) Effect of Implementation 1 of Solution 1

A concave or convex shape can be purposefully and selectively formed on a molded surface formed by the slidable cavity die.

(3) Effect by Implementation 2 of Solution 1

The resin can be readily separated from the slidable cavity die.

(4) Effects of Invention by Solution 2

A mold for injection molding a plastic molding has a molding surface for defining a cavity having a predetermined volume, and at least one or more transfer surfaces on the cavity surface, wherein the cavity is filled with a melted resin heated to a softening temperature or higher and injected thereinto to transfer the transfer surfaces to the resin with a resin pressure generated in the cavity. The mold has a cavity die for forming wall surfaces of the at least one or more cavity surfaces except for the transfer surfaces, and a vent formed in the cavity die, wherein the cavity die is made slidable for forming the entirety or part of the wall surfaces of the at least one or more cavity surfaces except for the transfer surfaces, a gas is injected from the vent and the slidable cavity die is slid away from the resin, when the resin pressure reaches

a predetermined pressure, to forcedly form a gap between the resin and slidable cavity die, thereby making it possible to purposefully and selectively form a molded surface formed by the cavity die with a convex or concave shape, to carry out the molding at a low pressure within a range in which a residual distortion produced in a molding will not affect the performance, and to consequently provide a molding having less distortion and highly accurate shape accuracy even if it is large, thick, or varying in thickness. Also, even with an injection molding method which is a low cost mass production method, in other words, even when the mold is heated below the softening temperature of a resin, a desired shape accuracy can be ensured, so that a cooling time (molding time) can be reduced to save the manufacturing cost.

(5) Effect of Implementation 1 of Solution 2

A concave or convex shape can be selectively formed on the molded surface formed by the slidable cavity die.

(6) Effect of Implementation 2 of Solution 2

The resin can be readily separated from the slidable cavity die. (7) Effect of Implementation 3 of Solution 2

The resin can be readily separated from the slidable cavity die. (8) Effect of Implementation 4 of Solution 2

The resin can be readily separated from the slidable cavity die.

(9) Effect of Implementation 5 of Solution 2

The cavity die can be fixed, so as not to move, by the resin pressure generated when the melted resin is injected into and filled in the cavity, so that the transfer surfaces can be highly accurately transferred onto the resin with the resin pressure generated in

the cavity.

(10) Effect by Implementation 6 of Solution 2

The mold can be simplified in structure.

(11) Effect for Implementation 7 of Solution 2

In continuous molding, a stable concave or convex shape can be formed without fail on a molded surface formed by the cavity die.

(12) Effect by Implementation 8 of Solution 2

The resin can be readily separated from the slidable cavity die. (13) Effect by Implementation 9 of Solution 2

Air injected from the vent can be prevented from introducing into the transfer surfaces to improve the shape accuracy of the transfer surfaces.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[Fig. 1]

A vertical sectional view of a conventional injection mold having a slidable cavity die.

[Fig. 2]

A vertical sectional view of an injection mold illustrating a first embodiment of the present invention.

[Fig. 3]

A vertical sectional view of the injection mold illustrating the first embodiment of the present invention.

[Fig. 4]

A vertical sectional view of an injection mold illustrating a second embodiment of the present invention.

[Fig. 5]

A vertical sectional view of an injection mold illustrating

a third embodiment of the present invention.

[Fig. 6]

A vertical sectional view of an injection mold illustrating the third embodiment of the present invention.

Description of Reference Numerals

1: Lower Half Mold

2: Upper Half Mold

3: Transfer Surfaces

4, 5: Cavity Dies Having Transfer Surfaces

6, 16: Slidable Cavity Dies

7: Cavity

8, 18: Vents

10: Gap

21: Hydraulic Cylinder

22: Pressure Controller

[TITLE OF DOCUMENT] ABSTRACT

[Abstract]

[Problem to be Solved by the Invention]

In an injection molding technique which forcedly defines a gap between a resin and a cavity die to produce a sink in a portion of the resin facing the gap, a molding method and a mold for injection molding are devised to permit manufacturing of a highly accurate molding at a low cost even if it is large, thick, or varying in thickness by reducing an adhesion between the resin and cavity die.

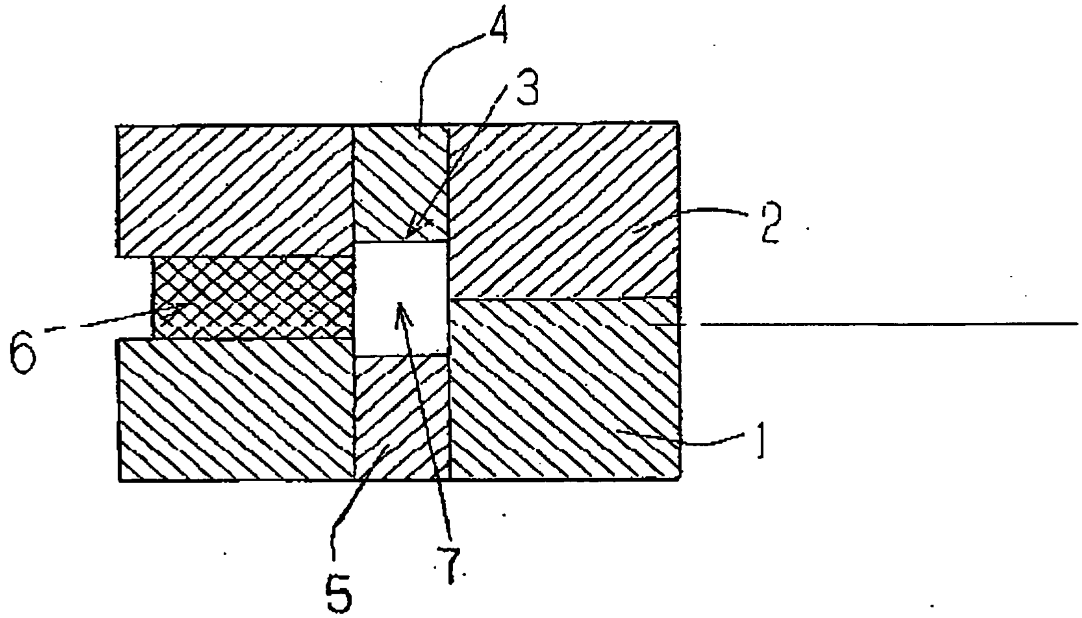
[Means Taken to Solve Problem]

In a method of molding a plastic molding which involves generating a resin pressure on transfer surfaces to bring the resin into close contact with the transfer surfaces, subsequently cooling down the resin below the softening temperature, and opening the mold to take out a molding, a gas is injected from at least one or more vents formed in a slidable cavity die, and the slidable cavity die is slid away from the resin, when the melted resin is cooled down below the softening temperature, to forcedly form a gap between the resin and cavity die.

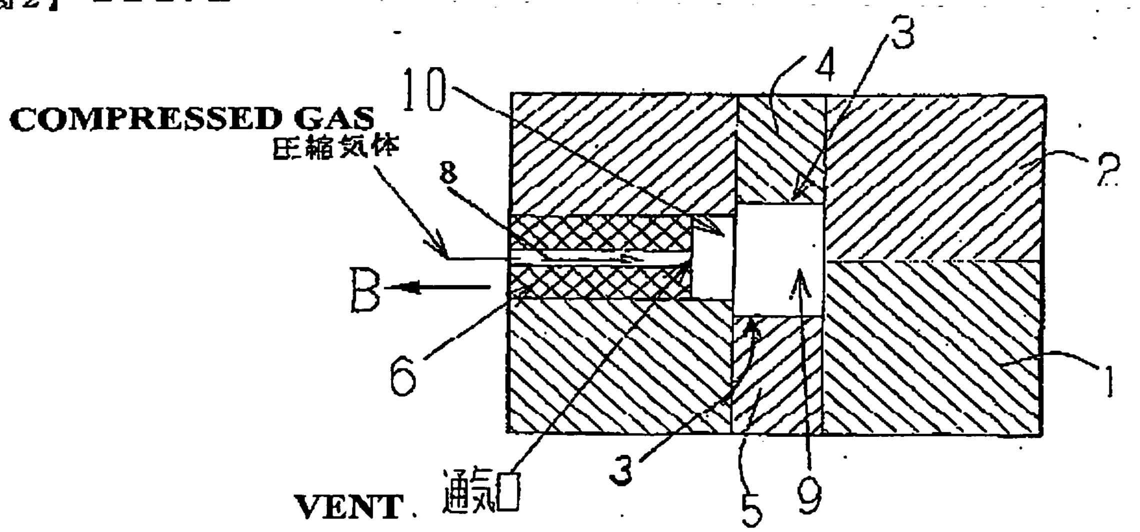
[Selected Drawing] Fig. 2

【書類名】図面

【図１】　FIG. 1



【図２】　FIG. 2



【図３】

FIG. 3

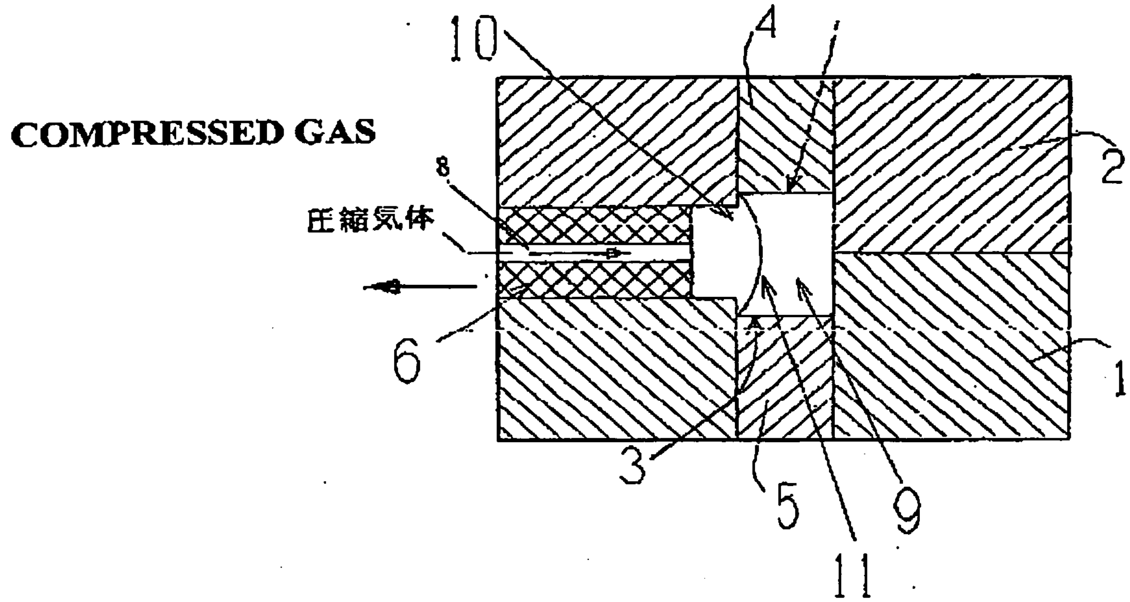
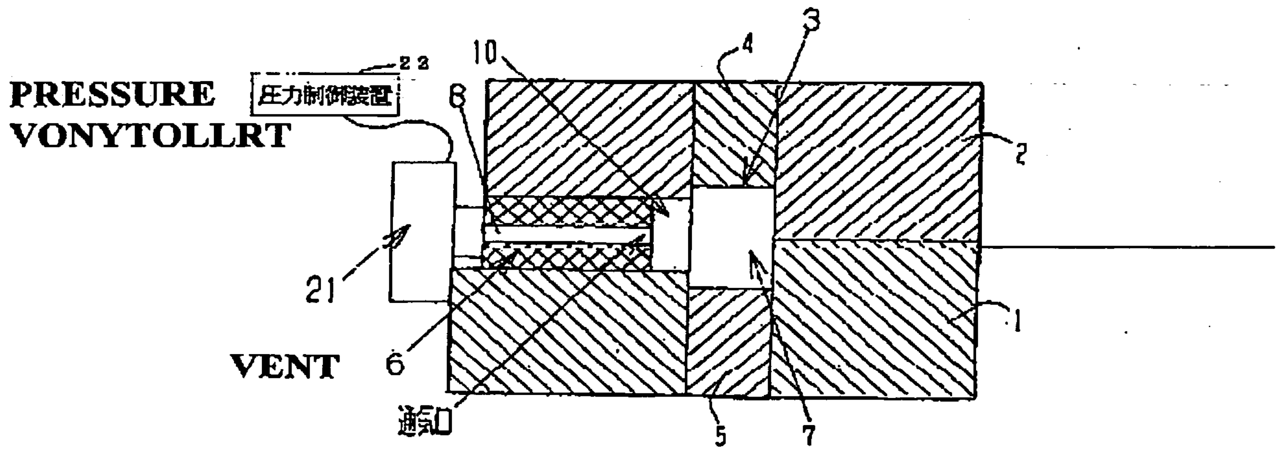


FIG. 4

【図４】



【図５】

FIG. 5

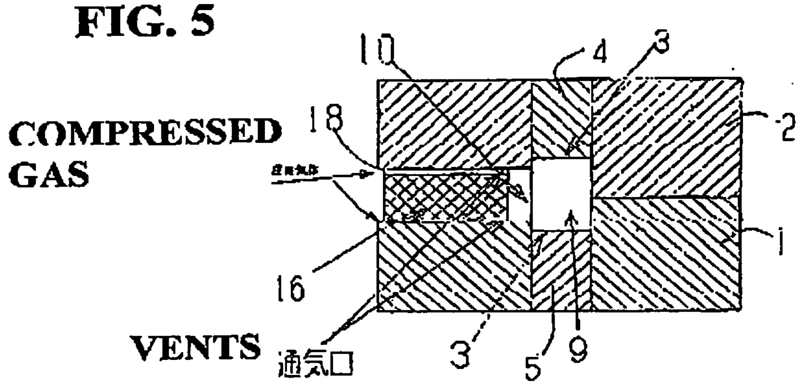
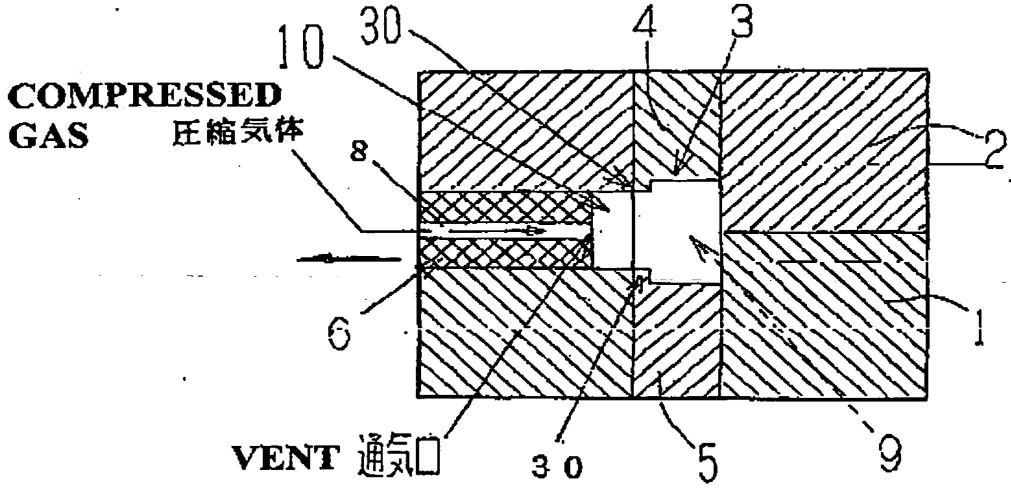

COMPRESSED GAS
VENTS 通気口
10
4
3
2
18
1
16
3
5
9

FIG. 6 【図６】


COMPRESSED GAS 圧縮気体
10
30
4
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VENT 通気口
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9